

ON SOME NEW GUINEA EARTHWORMS

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Earthworm faunas of a few areas have been more or less thoroughly surveyed. Our knowledge of the megadriles of so many other parts of the world is fortuitous, a result of one or more accidental finds. Now, as a result of the interest of a Professor of Social Anthropology in native beliefs about earthworm sounds, three new species are added to the New Guinea list.

A drastic dissection of at least one specimen of each series was necessary. Theoretically a dissected specimen should be the holotype since genus and family can be determined only from internal structure. However, a dissection, even when most carefully made after the best of preservation, inevitably destroys something of systematic value. Accordingly, a holotype is not designated. Cotypes are deposited in the Australian Museum, Sydney.

Pheretima bulmeri, n. sp.

Schrader Range, Kaironk Valley, on ground in forest camp at 8,300 feet, August-September 1968, 0-0-2 (W-4259). Along with two specimens of *P. schraderi*.

External characteristics. Size, 195 by 12 mm. Segments, 104. Colour, in dorsum, slate. Prostomium, seemingly prololobous (1), epilobous and with open tongue (1). Setae, present from iii (unrecognisable in ii), xviii/8,9, 80/region of lxxiv. First dorsal pore, at 12/13.

Polythecal, spermathecal pores minute and superficial (but not seen), at 4/5-8/9. Female pore, in xiv, within a white circular area. Clitellum, annular, brownish but lighter ventrally, dorsal pores, intersegmental furrows and setae unrecognizable. Male pores, minute, each in a slight transverse depression within a longitudinally elliptical porophore that slightly displaces 17/18 and that just reaches 18/19. Genital markings, none.

Internal anatomy. Septa, 8/9 present ventrally (only?), 9/10 lacking (?). Pigment, reddish brown, in circular muscle layer.

Gizzard, massive, in viii. Intestinal origin, in xv. Typhlosole, present from region of xxvii, low and rather irregular. Intestinal caeca, none found.

Hearts, unaborted dorsal portions in viii to gizzard, in ix on left side only, last pair in xii.

(Holandric?) Seminal vesicles, in xi, xii, large. Pseudovesicles, in xiii, vertical. Prostates, confined to xviii, compact, discoidal, of heart-shaped outline with apex laterally. Duct, from median cleft of gland, 4+ mm. long, in a u-shaped loop, ectal limb much thicker and with muscular sheen, lumen circular in transverse section.

Spermathecae, small, subesophageal, coelomic portion of duct shorter than ampulla. Diverticulum, shorter than main axis, reaching onto ampulla, with a short stalk and a slightly longer, ovoidal to ellipsoidal seminal chamber, the latter bifid on at least three diverticula. Numbers of spermathecae (left + right side); 4+5/v, 3+5/vi, 4+4/vii, 2+2/viii, 1+1/ix.

Reproduction. Seminal chambers of spermathecae contained sperm, proving that copulation had been completed. Testis sacs and seminal vesicles, as well as pseudovesicles, were filled with parasitic cysts. Testes and male funnels were not found and if present were rudimentary. The worm presumably was male sterile because of the heavy parasitic infestation. Cysts were lacking on and near the spermathecae.

If the dissected worm was female fertile, reproduction could have been amphimictic but the supposedly normal copulatory partner would have been cheated. Amphimixis is anticipated in normal worms.

Ingesta. Humus, including fibres 10-20 mm long, some with several lateral branches.

Parasites. In addition to the already-mentioned cysts, nematodes were present at least in coelomic cavities of viii-ix. Coelomic cysts reached a length of 1 mm.

Remarks. Both worms were macerated in a postclitellar region. However, presence of intestinal caeca in the macerated region is not anticipated.

Systematics. Polythecal species of *Pheretima* with spermathecal pores at 4/5-8/9 are *P. sibogae* Michaelsen, 1922, and *P. lavanguana* Gates, 1957. The first-named species is known only from a description of a macerated anterior fragment from the island of Lombok. Even though locations of the last hearts and of the testes are unknown, the species is distinguished from the New Guinea worms by the presence of genital markings and by the meroandry (instead of holandry). *P. lavanguana* is known only from the original description of a number of worms secured at Rennell I., British Solomons. The species also differs from the New Guinea worms in presence of genital markings and additionally by clitellar shortness, smaller size, paired female pores, presence of intestinal caeca, etc.

Pheretima kaironkensis n. sp.

Schrader Range, Kaironk Valley, rotten log in forest at 8,300 feet, August-September 1969, 3-0-0 (W-4258). R. Bulmer.

External characteristics. Size, 67-90 by 4 mm, the shortest worm a posterior amputee. Segments, 90, 97. Colour, white (alcoholic preservation). Prostomium, epilobous, tongue open (1 specimen), closed (1). Secondary annulations, none. Setae, present from ii, small rather closely but regularly spaced, in circles without regular gaps, retracted, tips just recognizable under high power of the binocular, vii/15, viii/17, xviii/11, 23/ii, 65/region of liii. First dorsal pore, possibly at 10/11 but certainly recognizable only from 12/13, pores small.

Spermathecal pores, minute, superficial, 5 pairs, at 4/5-8/9, quite obviously less than $\frac{1}{2}$ C apart. Female pores, equatorial in xiv (? in a space ca. 3 intersetal intervals wide). Male pores, transverse small slits at eq/xviii, ca. 4 mm apart, each at centre of a slightly elongated portion of xviii, male porophores not yet delineated. Genital markings, two pairs, of transversely elliptical outline, centred about at male pore levels, just behind 17/18 and just in front of 18/19.

Internal anatomy. Septa, none thickly muscular, 8/9-9/10 complete but membranous. Special longitudinal muscle band at mD, recognizable only behind 10/11. Pigment, none visible at incisions through body wall.

Gizzard, in viii. Intestinal origin, in xv. Intestinal caeca, paired, large, simple, with bluntly rounded anterior ends, from region of xxvii. Typhlosole, none.

Hearts; of ix slender and present on both sides, of x present on both sides, last pair in xii.

Metandric. Testis sacs, paired, subesophageal but not in contact with each other mesially. Seminal vesicles, vertical, in xii. Prostates, thin, flat, discoidal, at first seeming to have a transversely elliptical outline, but actually heart-shaped, one half being bent over against the other. Duct, ca. 1 mm long, from median notch, lumen slit-shaped in cross section.

Spermathecae, with ducts shorter than ampullae and mostly within the parietes. Diverticulum, small, from anterior face of duct, just below ampulla, berry-shaped, with 3-4 transparent chambers.

Reproduction. Although listed above as juvenile, a more accurate characterization might be early adolescent as GM rudiments were recognized after a second and more careful search under highest power of the binocular.

Amphimixis is anticipated because of absence of any evidence to the contrary.

Ingesta. Humus, including bits of wood up to 4 mm. long.

Remarks. The species is assumed to be unpigmented though some megadrile pigments are leached by alcohol.

Internal reproductive organs probably have been adequately characterized for systematic purposes. Absence of clitellate material necessitates an assumption that male pores and the genital markings will not be invaginated during further development but will remain superficial.

Systematics. Relationships are to be sought with species having paired, simple intestinal caeca from the region of xxvii, last hearts in xii, 5 pairs of spermathecal pores at 4/5-8/9 and testes only in xi. No such species has been recorded from New Guinea or elsewhere. *P. colossus* Cognetti, 1911, and *P. freesei* Ude, 1924, both from New Guinea and perhaps the most closely related, are distinguished by presence of hearts in xiii, greater soma size (in *P. colossus* reaching a diameter of 18 mm), muscularization of 8/9-9/10, etc. Spermathecae are more like those of *P. colossus*, diverticula lacking in *P. freesei*.

Pheretima schraderi n. sp.

Schrader Range, Kaironk Valley, rotten log, in forest at 8,200 feet August-September 1968, 0-1-2 (W-4257). *Idem*, on ground in forest camp at 8,300 feet, 0-0-2 (W-4259). *Idem*, "6 feet up in soil debris in pandanus palm, at 8,400 feet", 1-0-1 (W-4263). R. Bulmer.

External characteristics. Size, 235 by ca. 10 mm. Segments, 94, 101, 103. Colour, white (alcoholic preservation). Prostomium, deeply withdrawn into buccal cavity and seemingly prolobous (1), shape indeterminable as buccal cavity is everted (others). Setae, present from ii, regularly and fairly closely spaced, circles without regular gaps, viii/17, xvii/20, xviii/11, 13, 12, 83/region of lxxx. First dorsal pore, at 10/11 (2 tree worms), 11/12 (5 specimens).

Spermathecal pores, 4 pairs, small, transversely slit-like to crescentic, at 5/6-8/9, less than $\frac{1}{2}$ C apart. Clitellum, annular, brownish, dorsal pores occluded, intersegmental furrows obliterated, setae unrecognized, not quite reaching 13/14 but extending slightly into xvii (2). Female pore, at centre of a whitish area (4). Male pores, small transverse slits, each at centre of a gap in the setal circle about equal to 3-4 intersetal intervals, about 5 mm apart though seemingly not widely separated, special porophores not delineated.

Genital markings, small, transversely elliptical in outline, centred at male pore levels (5), indistinctly demarcated, greyish translucent areas, perhaps mostly in (or even confined to) xviii, seemingly crossing slightly into xvii and xix (1), most obvious on the acitellate individual where they may be confined to xviii.

Internal anatomy. Septa, none thickly muscular, 8/9-9/10 present but membranous. Special longitudinal muscle band at mD, recognized only behind 11/12. Pigment, none distinguishable at incisions through the body wall.

Gizzard, in viii. Intestinal origin, in xv. Intestinal caeca, simple, in xxvii-xxv (3). Typhlosole, rudimentary, quite irregular.

Dorsal blood vessel, filled with blood anteriorly and traceable to its bifurcation under the brain. Hearts; unaborted dorsal portions in viii to the gizzard, in ix-x present on both sides of each segment, last pair in xii (3).

Metandric. Testis sacs, subesophageal, not in contact with each other mesially. Seminal vesicles, in xii, large, bulging 11/12 anteriorly and 12/13 posteriorly, each folded onto itself twice into a longitudinal mass, with a small primary ampulla of different colour and texture, directed dorsally just behind 11/12. Prostates, confined to xviii, compact, discoidal, with a heart-shaped outline, apices laterally. Duct, from median cleft, not slender, 1.5 mm long.

Spermathecae, medium-sized, flattened against parietes, ducts shorter than ampullae and almost confined to body wall. Diverticulum, small, from anterior face of duct just below ampulla, bifid almost to base, or with three incisions of ental margin, or even with five possible seminal chambers.

Reproduction. A few flecks of male-funnel iridescence may have indicated presence of sperm thereon. Opaque areas in the otherwise translucent content of the spermathecal seminal chambers may also have been sperm. The texture of the unusually large seminal vesicles is consistent with a massive maturation of sperm. Reproduction is expected to be amphimictic.

Ingesta. Humus.

Parasites. Fairly large cysts in xviii-xix were visible through the transparent body wall of one specimen.

Remarks. The collector provided interesting comments on this species. Colour, yellow or bright yellow. Extremely muscular and vigorous. Emitted sprays of a yellow fluid from body pores and a particularly forceful jet to a range of four feet from the anus. With a barely audible squeak. Odour, distinctive and to the native Karam, offensive.

As in Burma this (and perhaps other) species sometimes comes to the surface in large numbers. The occurrence is regarded by the natives as an evil omen. One said to Prof. Bulmer, "If worms whose proper place is in the earth come to the surface and die, surely this means that men are going to die also." The native explanation of presence in trees might have been interesting.

Size of the adult pandanus worm, 250 by 10+ mm (without allowance for maceration), seems rather large for tree climbing, especially in absence of the adaptations shown by the smaller, truly arboricolous earthworms. Perhaps the adult reached the tree niche while a young juvenile. Size of the tree juvenile, 110 by 4 mm, already is larger than that of most arboricoles.

What is responsible for the yellow appearance of live worms, also mentioned for specimens of *P. kaironkensis* by Prof. Bulmer, remains to be determined. Softening of the anterior end, or eversion of the buccal cavity, obviated some prostomial characterizations. Segmental counts of setae usually were not attempted to avoid further handling of specimens already softened in postclitellar regions. Intestinal caeca and typhlosole were completely unrecognizable in the first dissected specimen.

Systematics. Relationships of the species are to be sought with metandric forms having spermathecal pores at 5/6-8/9, simple intestinal caeca in the region of xxvii, and the last hearts in xii. Species so characterized are: *P. queenslandica* (Fletcher, 1886), known only from Queensland, Australia. *P. spectabilis* Ude, 1932 (*non* Rosa, 1898), from an unknown locale in New Guinea. *P. versteegi* Michaelsen, 1938, known only from the original account of 3 softened specimens from Brenhef, Indonesian New Guinea. The present worms differ from the first-named species in number and location of genital markings, the single female pore, presence of 7/8, and absence of muscularization of 8/9-9/10. Differences from the second species are the characteristic heart-shape of the prostates and their confinement to xviii, absence of genital markings in xix-xxii. Differences from the third species are: smaller size, fewer setae per segment, membranous condition of septa 8/9-9/10, spermathecal shape, presence of genital markings, shorter and straight prostatic ducts.

Three further species must now be considered because of Michaelsen's failure to mention location of the last pair of hearts. From *P. bryoni* Michaelsen, 1932, known only from Bali, the New Guinea species is distinguished by larger soma size, better developed intestinal caeca, shorter spermathecal diverticula and presence of genital markings. From *P. doormani* Michaelsen, 1924, known only from specimens secured at Doormanpad, Indonesian New Guinea, the new worms differ in the larger soma, unpaired female pore, number and location of the genital markings, presence of septum 9/10. Differences from *P. vialis* Michaelsen, 1924, known only from the same locality as *P. doormani*, are: unpaired female pore, presence of genital markings, presence of 8/9, membranous condition of 9/10, undiverticulate spermathecae, seemingly with a much less muscularized spermathecal duct.

Too much importance probably should not be attributed to some septal characters reported in the past. Internal evidence in the text occasionally indicates determination of serial septal order was erroneous. The above-mentioned differences do distinguish some species of *Pheretima* from each other. Systematic values in the instances just cited require confirmation from much larger samples, more especially from better preserved material.

Other Species

Three lots of smaller earthworms were in too poor condition to determine most of the desired external characteristics. Dissection of anterior fragments enabled securing some data demonstrating existence of yet other species in the Kaironk Valley. Like the preceding all are of the same genus. To date no

reason has been found for thinking that any New Guinea endemics are not of the genus *Pheretima* as now understood.

Pheretima sp. I

Schrader Range, Kaironk Valley, dug up 6-18 inches below surface in Miscanthus fallow, 7,300 feet (W-4260). R. Bulmer.

External characteristics. Colour, white, except the dark slate of clitellar segments. Spermathecal pores, 5 pairs, at 4/5-8/9. Female pore, in xiv, at mV. Male porophores, indistinctly delimited but probably circular and reaching 17/18, 18/19. Male pores, each minute, superficial, at centre of a small circular area at middle of a porophore. Genital markings, none.

Internal anatomy. Septa, 8/9 present but membranous, 9/10 lacking, 4/5-7/8 thickly muscular. Intestinal caeca, none. Hearts, in ix on right side only, last pair in xii.

Holandric. Seminal vesicles, in xi, xii. Prostates, extending through several segments. Duct, 3+ mm long, in a U-shaped loop, ectal limb thicker and with muscular sheen. Spermathecae, small, subesophageal, ducts shorter than ampullae. Diverticulum, from median face of duct close to parietes, pear-shaped, shorter than main axis but reaching onto ampulla.

Abnormality. Clitellum and male pore of left side one segment anterior to positions on the right side.

Remarks. Spermathecal and male pores were not seen. Positions were determined from the dissection. Differences between the prostates of this species and those of the preceding taxa may prove to be of some systematic interest.

Pheretima sp. II

Schrader Range, Kaironk Valley, 4-6 feet up in soil and debris in Pandanus palm, 8,400 feet (W-4261). R. Bulmer.

External characteristics. Colour, red, lacking at segmental equators and just under intersegmental furrows. Spermathecal pores, one pair at 6/7. Genital markings, none.

Internal anatomy. Septa, 8/9 present but membranous, 9/10 lacking, none thickly muscular. Intestinal origin, in xvi. Intestinal caeca, simple, in region of xxvii. Last hearts, in xii.

Holandric. Seminal vesicles, in xi, xii. Spermathecal ducts, without sheen but not slender, longer than ampullae. Diverticulum from anterior face of duct midway between parietes and ampulla, with short, slender stalk and longer, ovoidal to ellipsoidal seminal chamber.

Reproduction. Although dissected worms are acitellate some sperm already had aggregated on the male funnels. No iridescence was distinguishable in spermathecae (2 specimens). Right spermatheca and left prostate of one worm were lacking. Such defects in the genitalia are of the kind that develop after reproduction becomes parthenogenetic. Although sperm are present on male funnels, parthenogenesis is suspected but in absence of male sterility. If that is true, an amphimictic population may have more than one pair of spermathecae though how many should not now be guessed.

Remarks. This is the first time there has been reason to suspect parthenogenesis in a New Guinea pheretima.

Pheretima sp. III

Schrader Range, Kaironk Valley, 4-6 feet up in soil and debris in pandanus palm, 8,400 feet, (W-4262). R. Bulmer.

Remarks. The dissected fragment, white, was too young to show rudiments of spermathecae but the following data were obtained.

Septa, 8/9-9/10 present but membranous, none thickly muscular. Intestinal caeca, simple, in region of xxvii.

References

- Bulmer, R., 1968.—Worms that croak and other mysteries of Karam Natural History. *Mankind*, 6:621-639.
 Hide, R. L., 1969.—Worms and sickness. *Mankind*, 7:149-151. (Reference added by editor).